Huntington River Water Quality Study – 2015

Summary of Findings

The summer of 2015 marked the eleventh year of Huntington River Conservation Partnership (HRCP) water quality monitoring, and the 15th year on the Huntington portion of the river. With laboratory support from a Vermont Dept. of Environmental Conservation Larosa Grant, a large number of volunteers from Huntington and Richmond sampled specified locations along the length of the Huntington River on a weekly basis for bacterial contamination by *E*. *coli*. Total Phosphorus levels were measured for the first time.

- There were relatively few cases where E. coli contamination exceeded the Federal and now also the State Standard, though values frequently were above the old State Standard. In no cases did overall Geomean (site or date) exceed Standard. One explanation based on prior studies for the relatively few values above current Standard is that weather was quiet with little rainfall in the period just before sampling, the higher values where rainfall occurred.

- The patterns across sites on a given date in several cases were characterized by isolated peaks that might suggest a spot source immediately up stream or at the sites. At the same time, the site location of these peaks when observed was not consistent from week to week.

- Though there were several cases where contamination increased moving down river, that was not invariably the case. The overall Geomean by site rose moving down river, but again in no consistent pattern.

- The pattern of peaks and valleys generally was similar in single date comparisons between sites, as found frequently in past years, suggesting that some general contributor such as runoff was affecting multiple sites.

- There was a modest correlation between rainfall over the 24 hours prior to sampling and overall Geomean for the day, much weaker with pooled results across all years. Correlations between river level and contamination were very weak.

- The correlations between rate of change in water level were weak when water level was compared with overall river Geomean or with Horseshoe E. coli contamination. Strong correlations might be difficult to observe due to the several cases where the amount by which water level changed in advance of samplings was small.

- Results from monthly, rotating sampling generally reflected results from the weekly measurements. Noteworthy, however, were certain unusually high values for Hollow Brook for the second year running.

- Total Phosphorus (TP) measurements were undertaken for the first time in 2015 at the request of a Huntington Conservation Commission member. Slightly higher values for the first week were followed by more-or-less even values for the duration of the study. Mean values (7.9 ppb) were well below the standard for Class B, Medium, High-Gradient streams established by Vt. Agency of Natural Resources of 15 ppb.

Overall Results

What follows is a summary of the results from the 2015 Huntington River Water Quality study. The reader is encouraged to review the 2006 and 2007 Reports for discussion of definitions, methods, Federal and State Standards and other background material. Past Reports can be found at: www.huntingtonriver.org. *E. coli* (of any species) is considered a sentinel for fecal contamination, indicating the possible presence of human pathogens. The identification of pathogenic *E. coli* species has not been attempted.

Figure-1 shows the sampling locations for the main study sites. Funding constraints meant that the weekly sampling sites along the River were reduced to twelve, and the sites along the Winooski River dropped. Monthly samples continued to be taken. As for 2014, samples were taken over ten weeks as compared to 13 weeks for previous studies of the Huntington plus Richmond watershed.

Table 1 presents the complete 2015 data set. Data entries are color-coded indicating values exceeding the Federal Standard (pink: 235, measured as *E. coli* / 100 ml). Beginning in 2012, the State standard was adjusted upwards from 77, to the Federal Standard of 235. Values above 77 are colored in yellow to allow comparisons with years past when that was the State Standard.

Similar to 2014, relatively few samples were above Federal Standards, mostly clustered at two dates (see **Tables 2 and 3** for yearly comparisons). One likely cause based on results from past years was significant rainfall the 12-24 hr before samples were taken (6/23, 7/28, 8/4; see below, **Figure 5.1**). The number of samples above the old State Standard (pink plus yellow) was somewhat lower than the average since the study began, bearing in mind there were fewer sampling sites. In no case was the Geomean for a given date above the Federal / current State Standard, though the old State Standard was exceeded seven times. The overall Geomean for each weekly site never exceeded the Federal / new State Standard, though the value for the old State Standard was exceeded at nine of the twelve sites.

Samples taken on a monthly, rotating basis showed a similar pattern (**Table 1**). Noteworthy were high values on two occasions for Hollow Brook for which high values have been observed before (**Table 2**). One of the high values for Hollow Brook occurred in isolation from values for all of the other sites for that date (8/25) also true on one occasion in 2014 (see 2104 Report). Such a result might be attributable to a point source of contamination.

Quality Assurance

During the 2015 sampling season, 135 regular *E.coli* samples were submitted. Eleven additional samples (8.1%) were taken as quality assurance field duplicates (**Table 4**). The VTDEC Laboratory quality assurance objectives for *E. coli* on Quanti-tray are the following: <25 colonies, 125% relative percent difference (%RPD); >25 colonies, 50% RPD. Overall, the mean %RPD was 35.6%. This is within VTDEC objectives for QA duplicates, though four individual duplicate comparisons exceeded the QA objectives.

Figures 2 and 3 look at sample location by date. Geomean values by-in-large were below the Standard (enlarged red symbols for those above Standard; **Figure 3**).

The patterns for a given date, though varied, in several cases were characterized by isolated peaks that might suggest a spot source immediately up stream or at the sites. Note, however, that the site location of these peaks when they were observed was not consistent from week to week. Such spikes have been observed in the past and illustrate how dilution, bactericidal activity and / or other, unknown factors cause significant reductions in contamination further down river. The short life-span of viable *E. coli* once it leaves the animal digestive tract is well-known. Though weekly values tended to rise as one moved downstream, that was not invariably the case. The overall Geomean by site rose as one moved down river **Figure 4.1**. At the same time it is difficult to recognize a specific pattern when previous results are compiled (**Figure 4.2**).

Figure 5 examines each dates at individual sites. Again, larger, red triangles indicate values above Standard. Generally speaking, the pattern of peaks and valleys was similar in between-site comparisons. This suggests that some general contributor such as runoff was affecting each site.

Past results have suggested that high levels of contamination follow heavy rains, interpreted to indicate contamination from land runoff. This was based on significant rain in the 12-24 hour period before sampling and the co-occurrence of high levels of contamination at multiple sites along the river. As shown in **Figure 6.1**, there was a modest correlation between 24 hour rainfall and overall Geomean for the day in 2015 (r^2=0.69) indicating 69% of the variability in the Geomean values can be attributed to rainfall occurring the 24 hour before sampling. Pooled data across all years point to a weaker correlation (**Figure 6.1**; r^2 = 0.24). As before, interpretation is confounded by the number of observations where there was no rainfall.

The relationship between river and contamination showed no correlation between river level and contamination both measured at the popular Horseshoe Bend swimming hole just below Huntington Lower Village against overall River Geomean (**Figure 6.2**). The correlation was better but remained weak when the comparison was between river depth and paired E. coli measurements at Horseshoe.

Half hourly measurement of water level were made for the third year running, made possible by a donation of continuous data-logging equipment by the US EPA in 2012. **Figure 6.3** shows the pattern of change in river level the 48 hours before sampling (RED triangles indicate 12 and 24 hr prior to sampling). Noteworthy was the flatness of the curves for most dates, 7/14, 7/21 and 8/4 somewhat being exceptions.

Despite the general lack of water level change before sampling for most weeks, nonetheless the relationship between 12 hour change in water level change overall River Geomean and also Horseshoe contamination, where water level was measured was examined (**Figure 6.4.1.** (Red symbols indicate when water level was falling – see **Figure 6.3**). There was not as strong a correlation between rate of change in water level when water level was compared with overall river Geomean (r^2 = 0.58) and a much poorer correlation with Horseshoe E. coli contamination (r^2 = 0.20). The stronger correlations observed previously for 2014 may not be reliable as they were driven primarily by a single value (see 2014 Report). The 2015 correlations at 24 and 48 hours were even poorer (not shown). A factor to bear in mind when interpreting the 2015 data is that the amount by which water level changed was small for many of the weekly values.

Figure 6.4.2 shows compiled data from the three past years during which half-hour water levels were measured. The highest correlation was for the 12 hour water level change (r^2 = 0.73 vs overall river Geomean; r^2 = 0.83 vs Horseshoe contamination) again however dependent on a

limited number of high values. The correlations were unimpressive at 24 and 48 hours (not shown). Though it is true that levels were falling the majority of the time, there was no obvious difference between the impact of rising vs falling levels. Presumably a recent runoff event is signified in both cases.

Box Plots - variability

Geomeans again were computed for data analysis, because of the wide range of values and the fact the data are not normally distributed (see 2006 Report for further explanation). The spread of values is illustrated by the use of "box plots" (**Figure 7)**. Box plots are often used to assess the variability in the data (see 2007 Report for details). The intent is to compare values for a specific site and not to make comparisons between sites. Hence the vertical axis scale is not the same for each site: using the same scale makes it difficult to observe the data distribution in certain cases. All but one site (Spence) had an outlier. Introducing the caution of data interpretation form a statistical point of view. Past yearly results have been characterized in general by a number of sites with outliers.

Winooski River

Studies of the Winooski River were not undertaken in 2015 due to budgetary constraints.

Total Phosphorus

Total Phosphorus measurements were undertaken for the first time in 2015, with the aim at assessing the magnitude of any TP runoff problem. As shown in **Figure 8**. Values were higher for all sites the first week (6/23) otherwise being more-or-less even for the other sample weeks. Given two sample weeks when there appeared to be an upward trend as one moved down river, weekly values otherwise were flat. In 2014, the Vermont Agency of Natural Resources established a standard of 15 ppb (μg/L) for TP (at low median monthly flow) in Class B Medium, High-Gradient Streams. At only one site on the June 23 sampling date was the 15 ppb standard exceeded, and then only slightly. Throughout the remainder of the season, TP levels remained well within the standard for the Huntington River.

We conclude that Phosphorus nutrient release is not a considerable problem for the Huntington River watershed. Although, a season with differing flow conditions may indicate otherwise. We're currently not planning to continue TP sampling in the 2016 season.

Comments

The recommendation from past results remains in place in terms of avoiding river use after a major rainfall event.

Thanks to all the volunteers

Many thanks to all the volunteers whose efforts made the study possible. It was their effort over the years that caused the Huntington River to be chosen as one of only two study sites in the State to be supported through State and Federal funding. All should be proud of the effort and result.

Those interested in learning more about the Huntington River project should go to: http://www.huntingtonriver.org

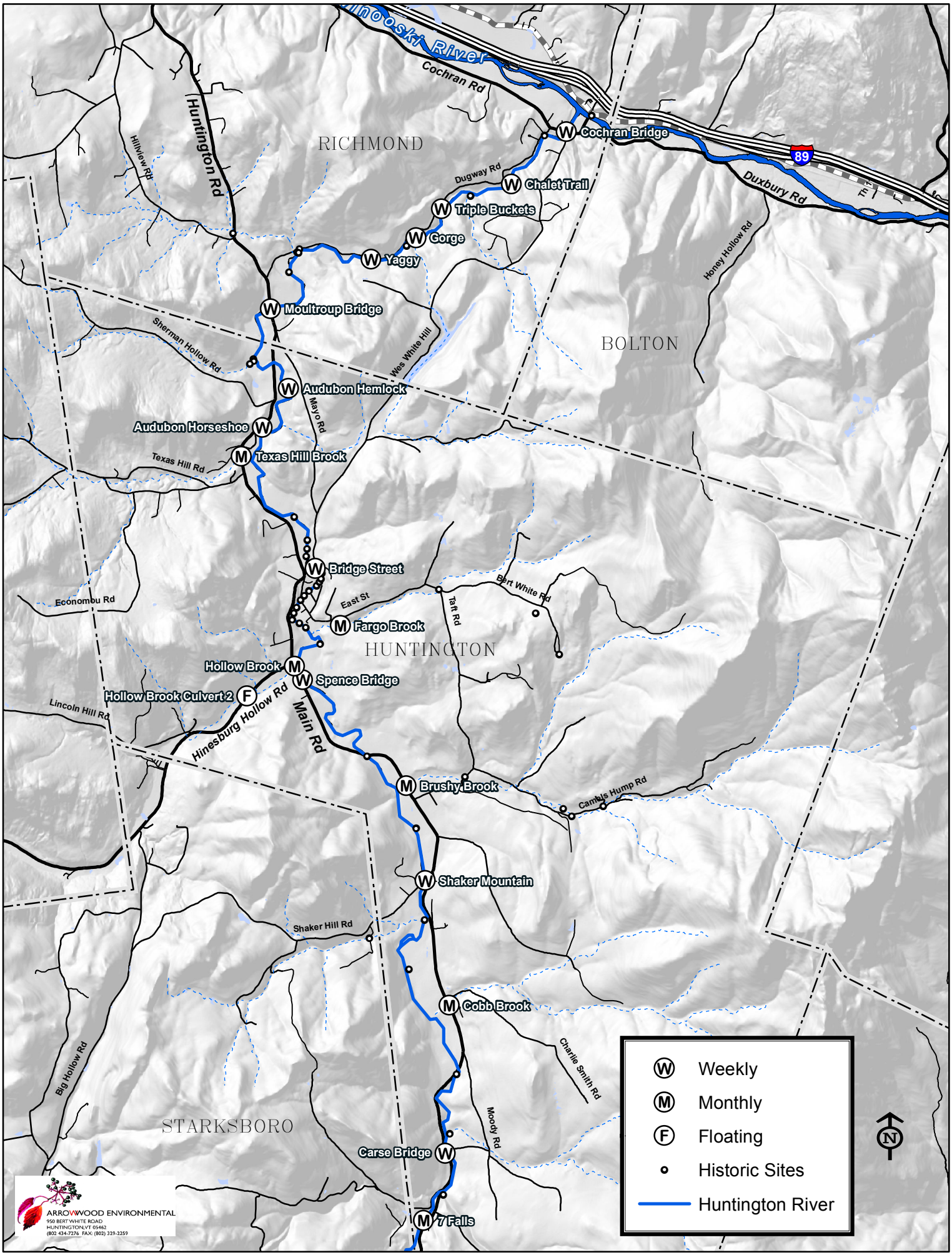
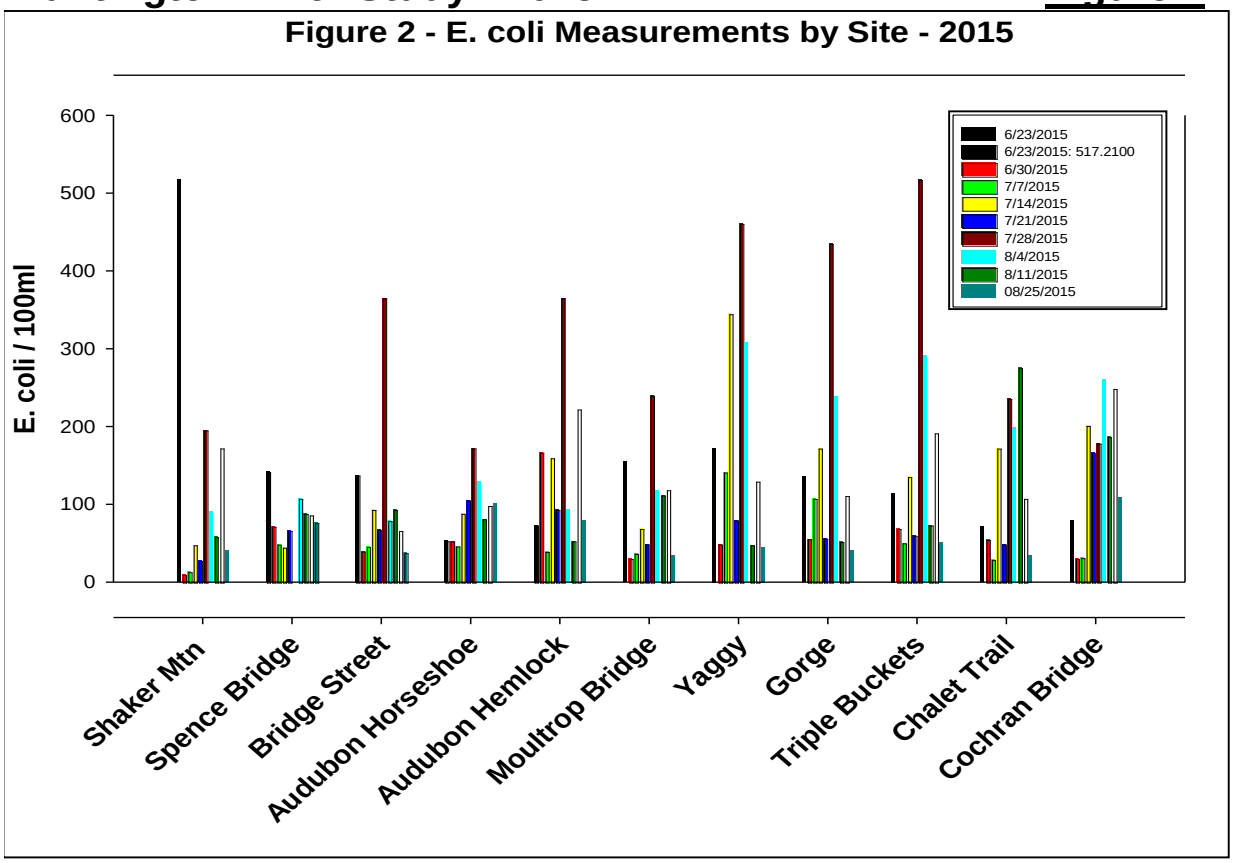


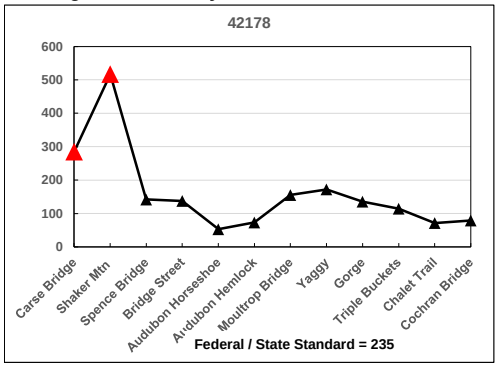
FIGURE 1: Sample Sites

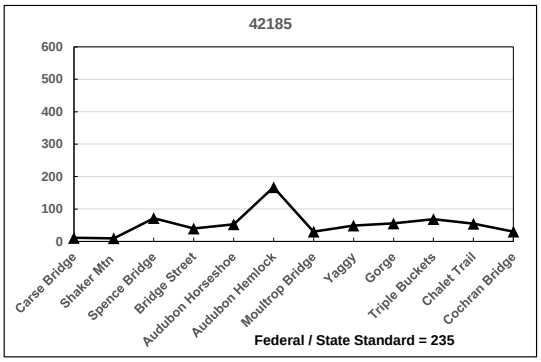
Huntington River Study - 2015

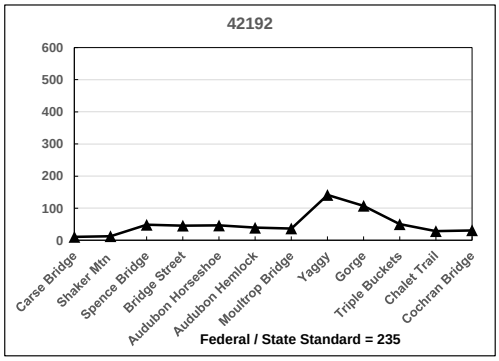
Figure 2

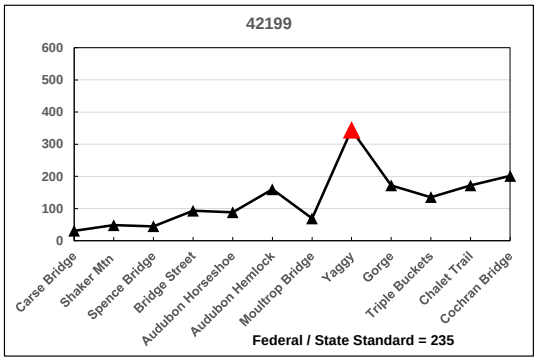


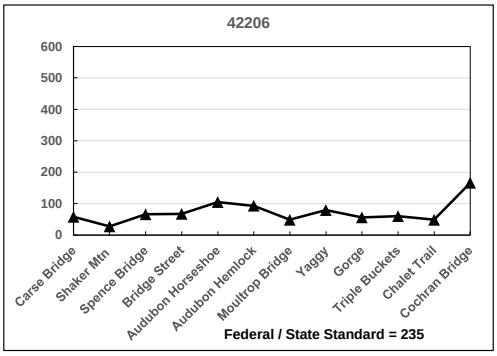
Huntington River Study - 2015 **Figure 3**

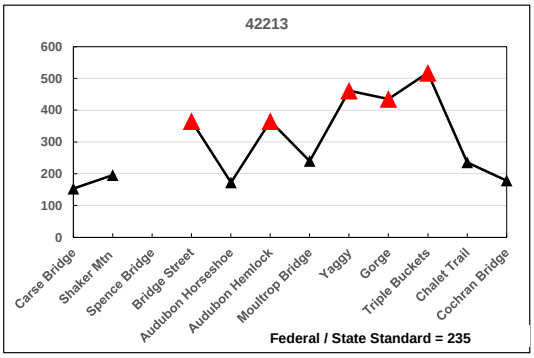


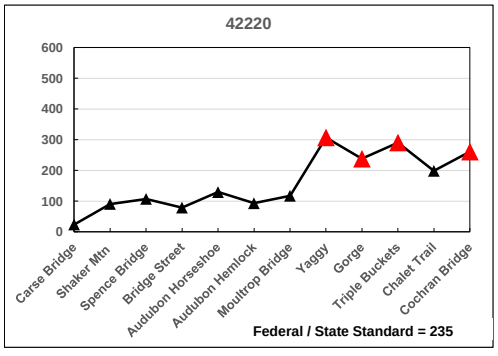


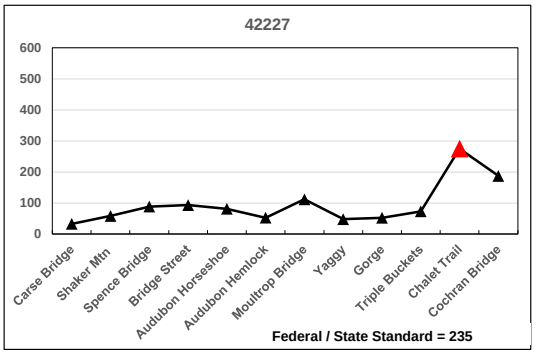


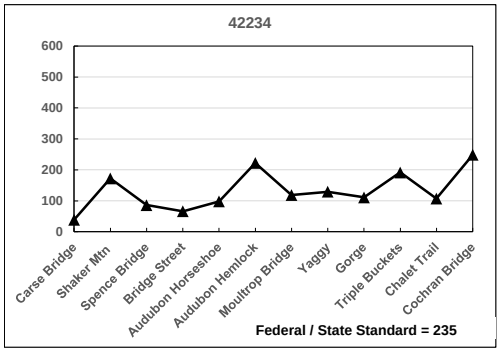


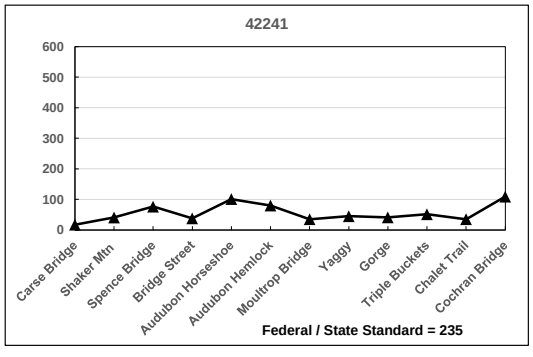




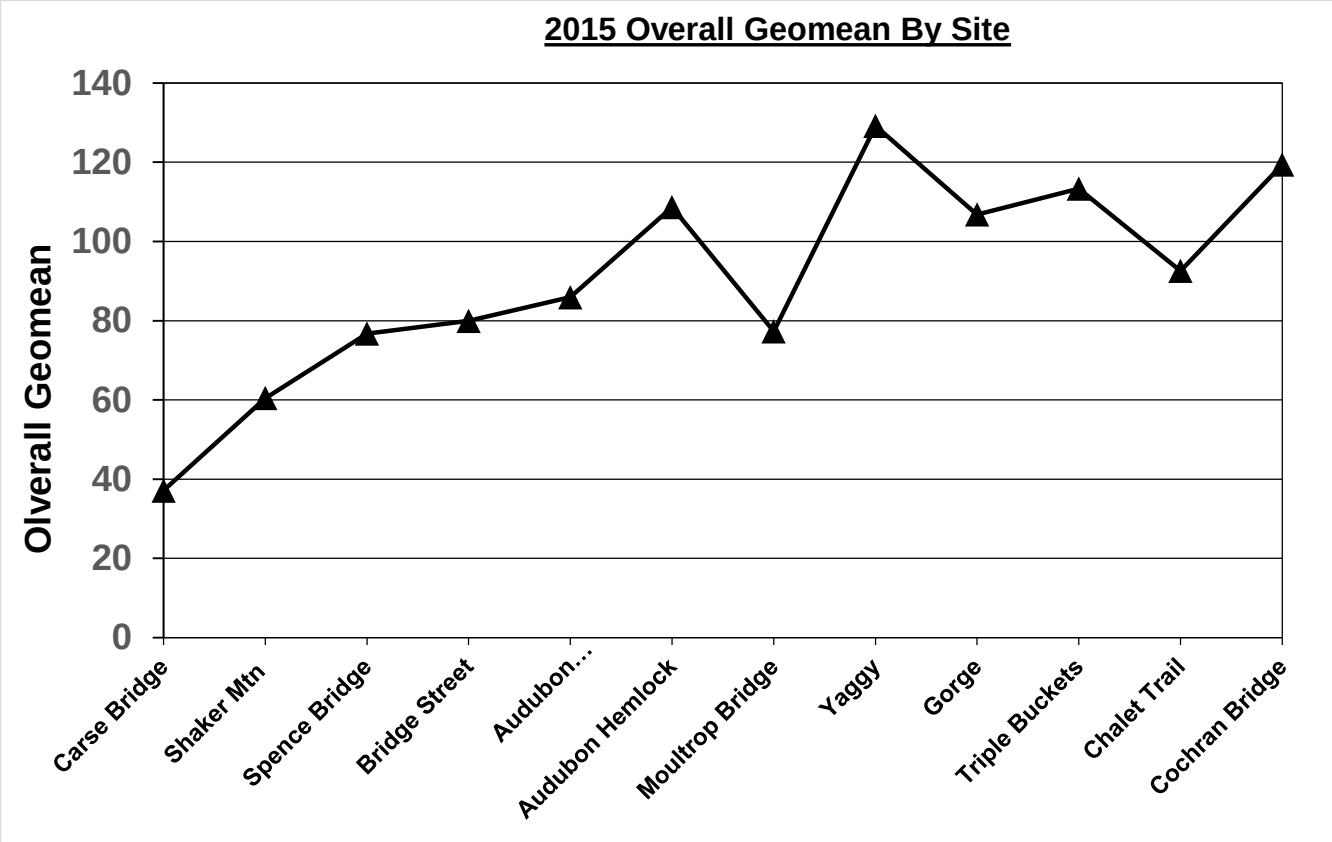






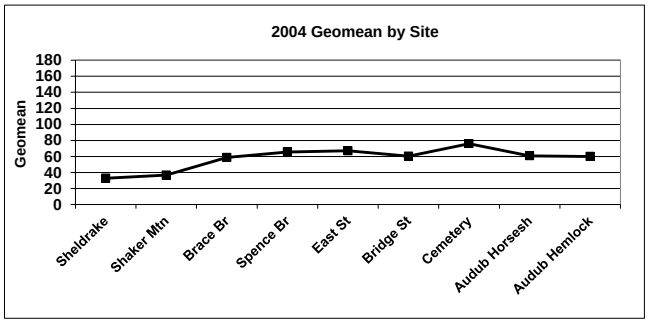


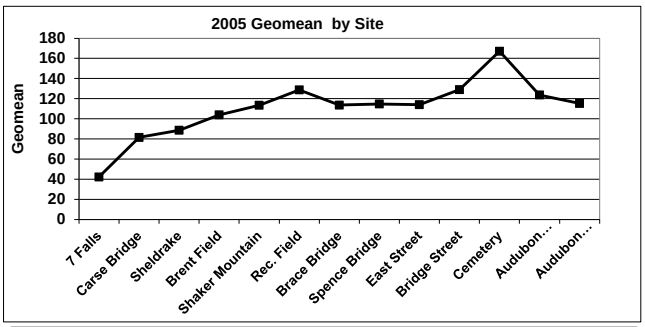
Huntington River Study - 2015 **Figure 4.1**

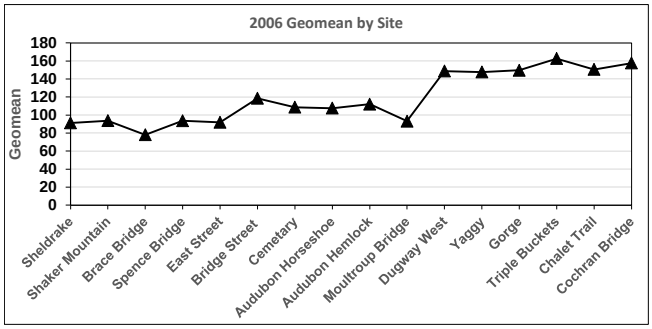


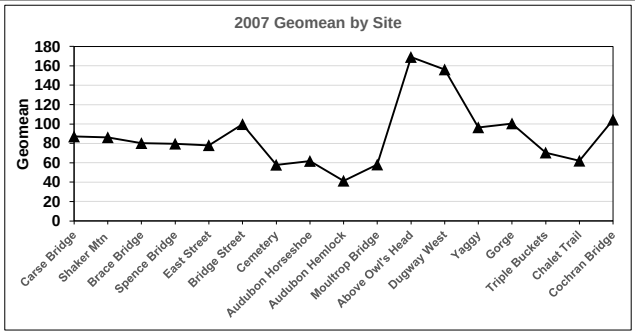
Compiled Results - Geomean per Site - All Years
Federal / State Standard = 235

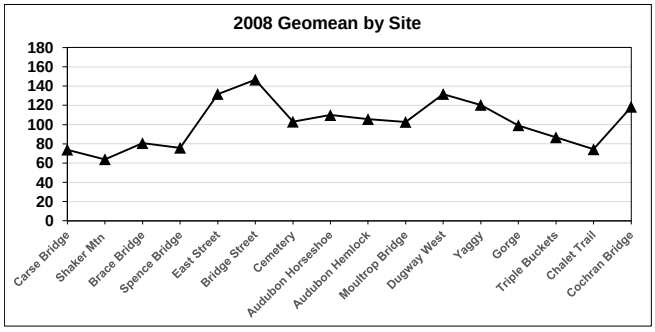
Figure 4.2

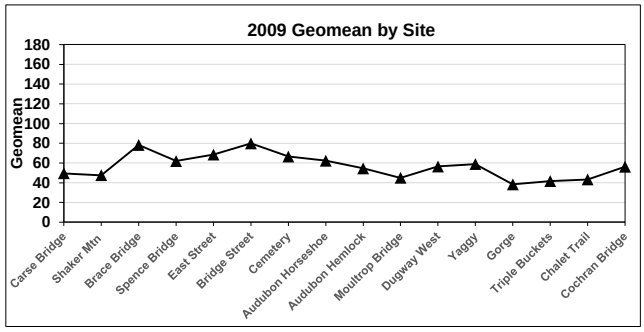


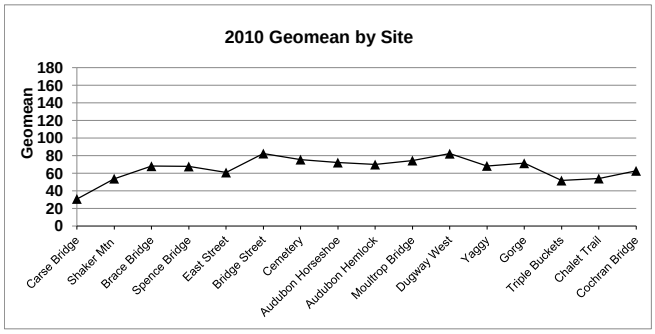


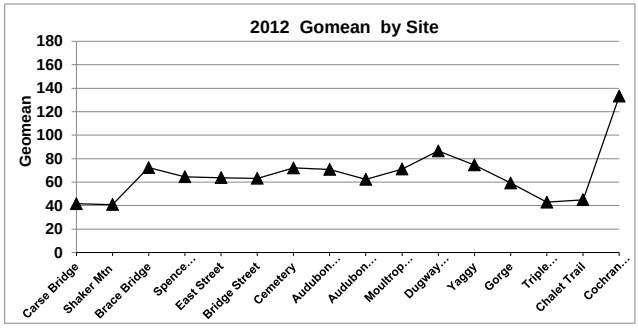


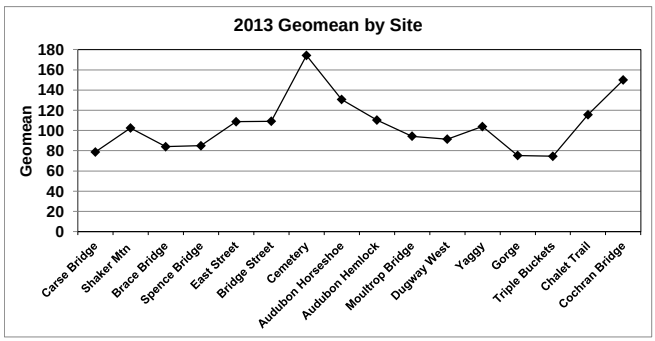


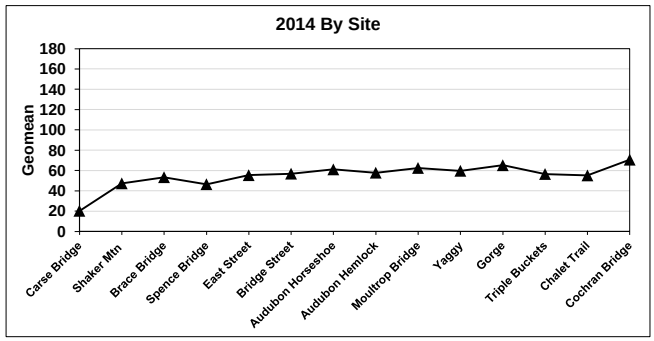


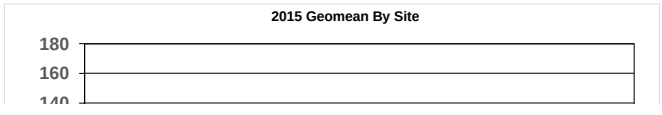






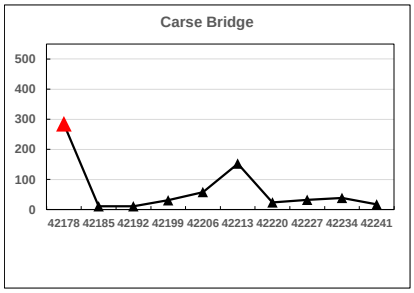


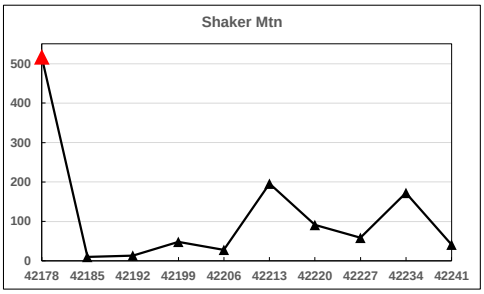


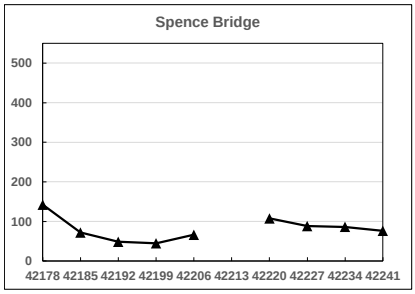


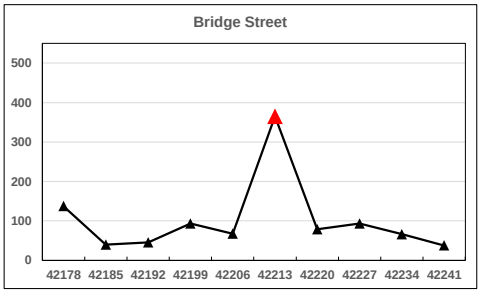
Huntington River Study - 2015 **Figure 5**

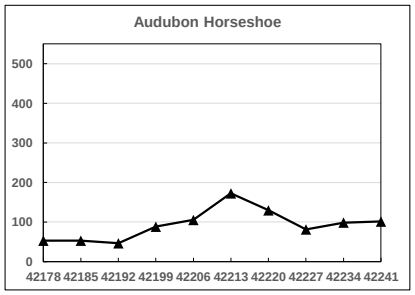
Federal Standard = 235

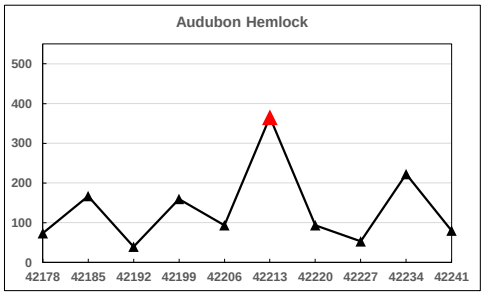


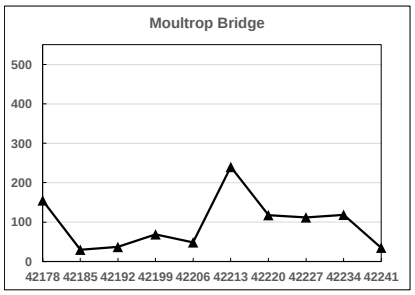


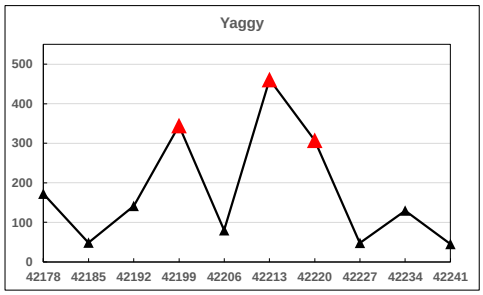


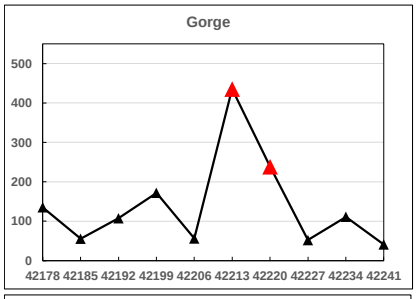


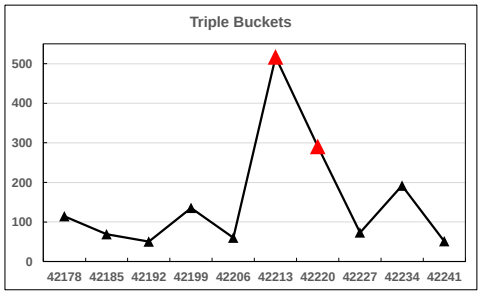


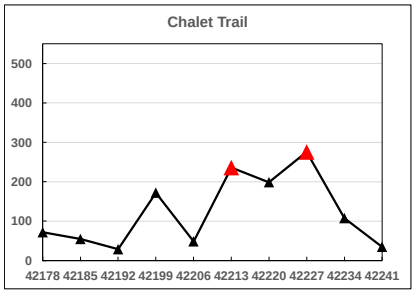


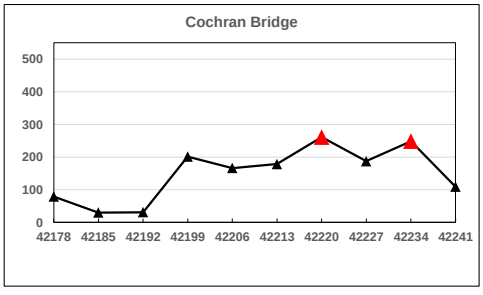


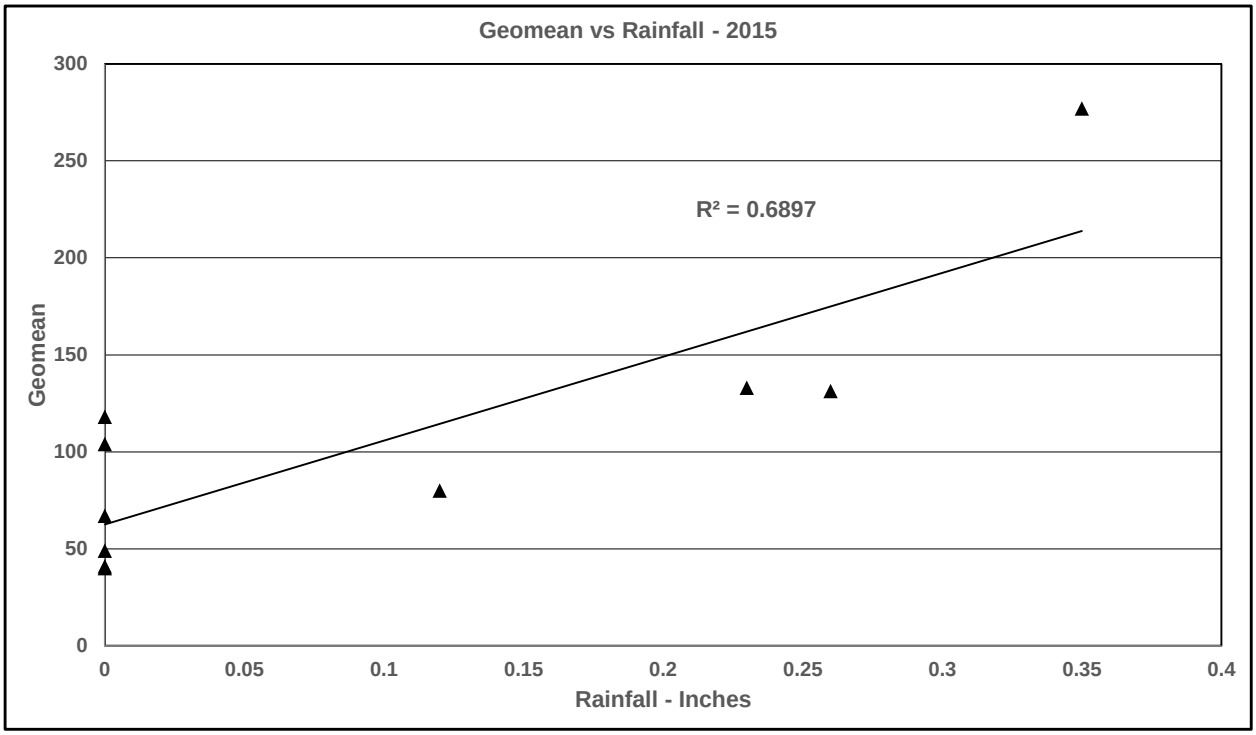











Geomean vs Rainfall - 2015
300
250
200
150
100
50
0
Geomean
R² = 0.6897
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Rainfall - Inches

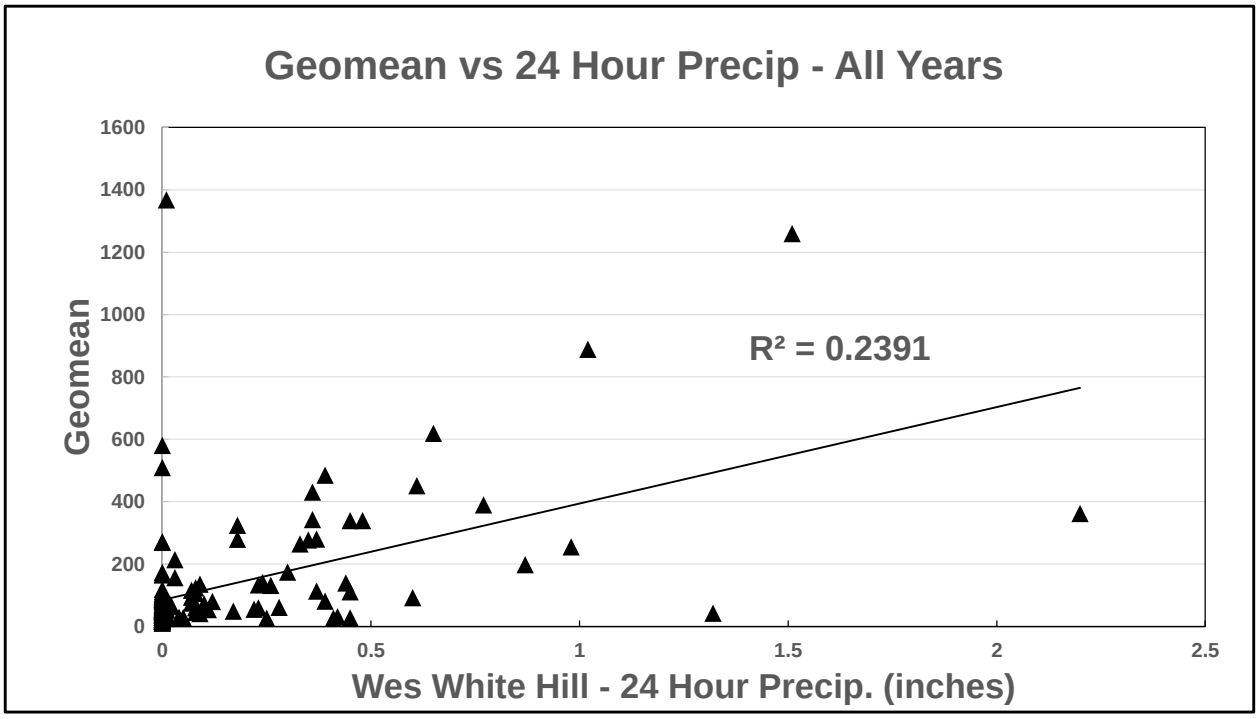
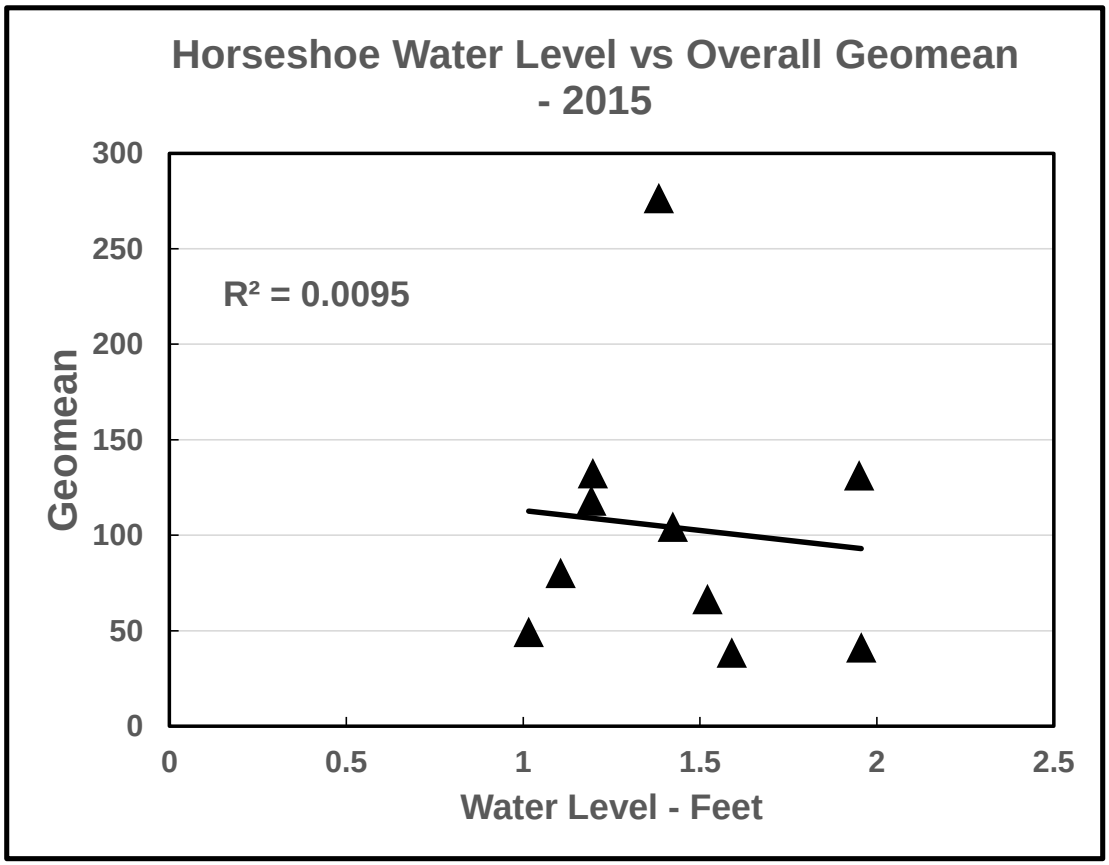
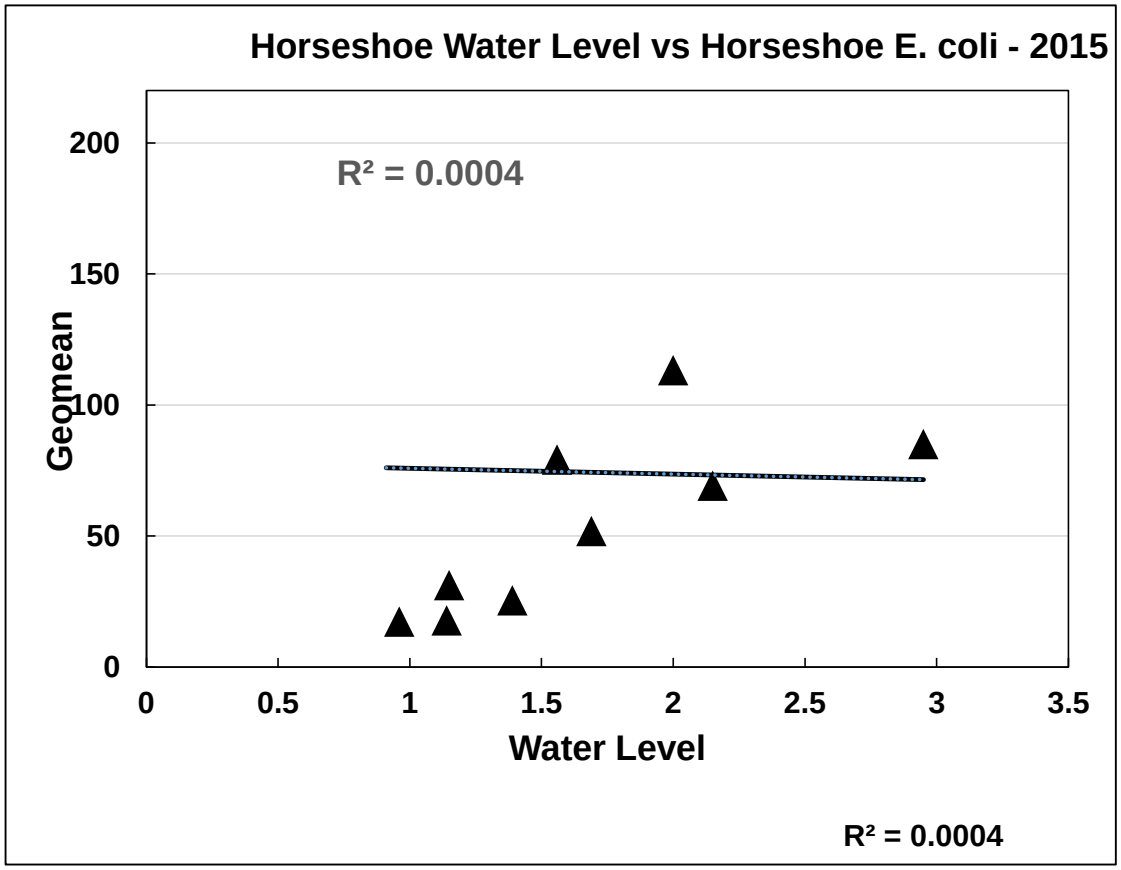
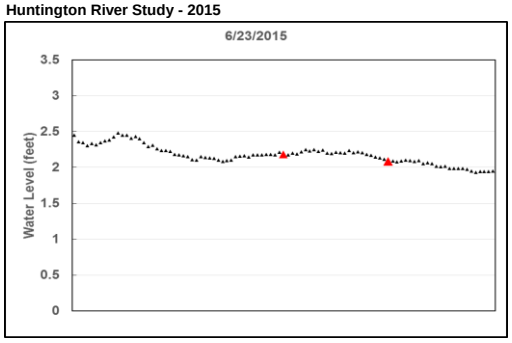

Geomean vs 24 Hour Precip - All Years
1600
1400
1200
1000
800
600
400
200
0
Geomean
R² = 0.2391
0
0.5
1
1.5
2
2.5
Wes White Hill - 24 Hour Precip. (inches)

Figure 6.2


Horseshoe Water Level vs Overall Geomean - 2015
R² = 0.0095
Geomean
Water Level - Feet
300
250
200
150
100
50
0
0
0.5
1
1.5
2
2.5


Horseshoe Water Level vs Horseshoe E. coli - 2015
R² = 0.0004
Geomean
Water Level
R² = 0.0004
200
150
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5

Huntington River Study - 2015 **Figure 6.3**



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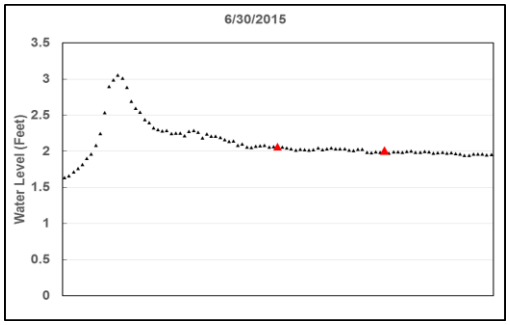

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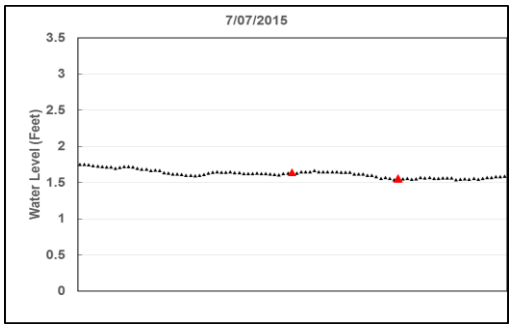

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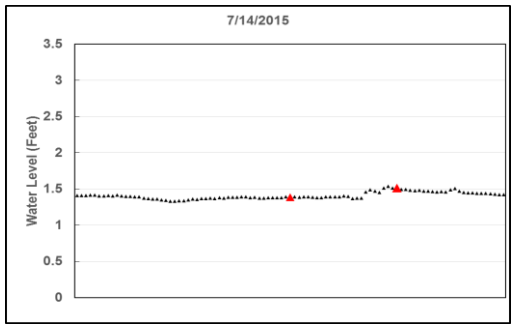
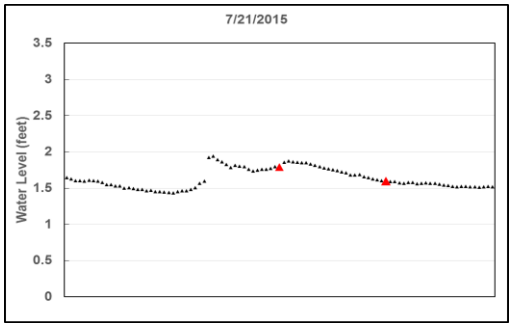


Geomean = 104.4



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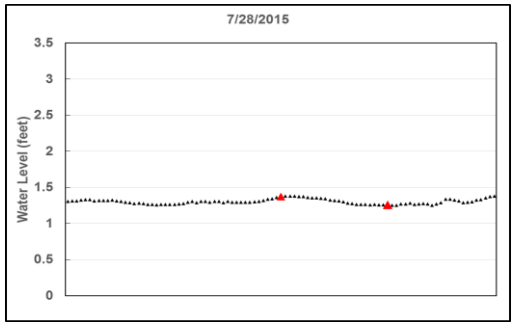

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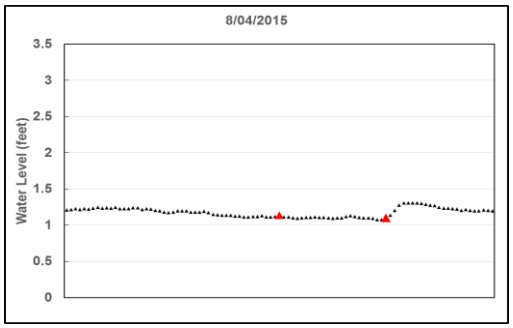

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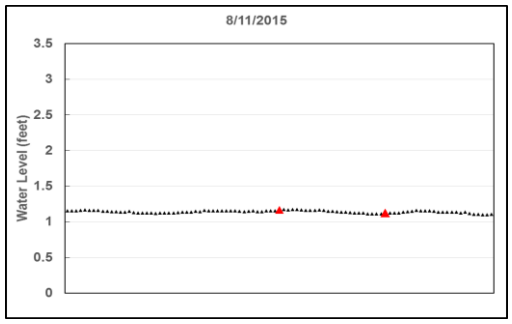

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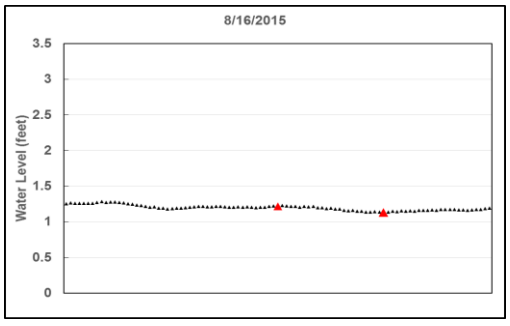
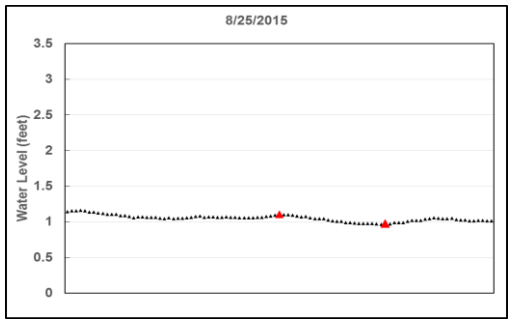


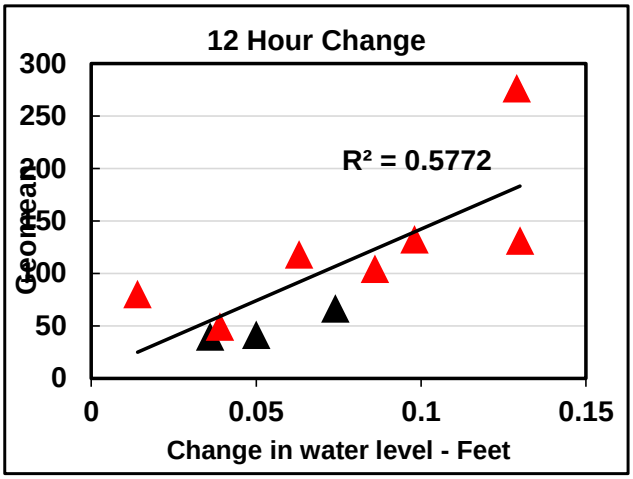
Geomean = 118.1

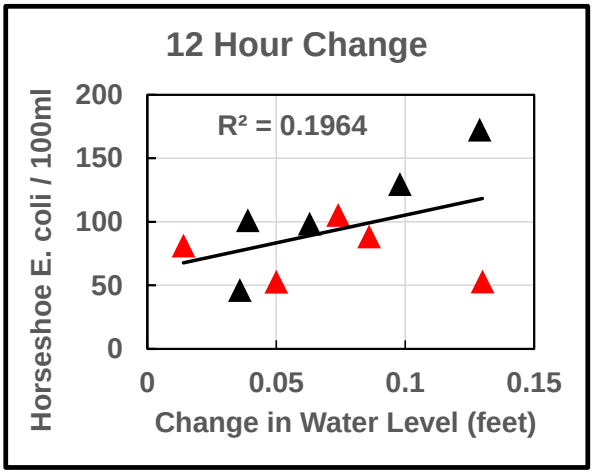


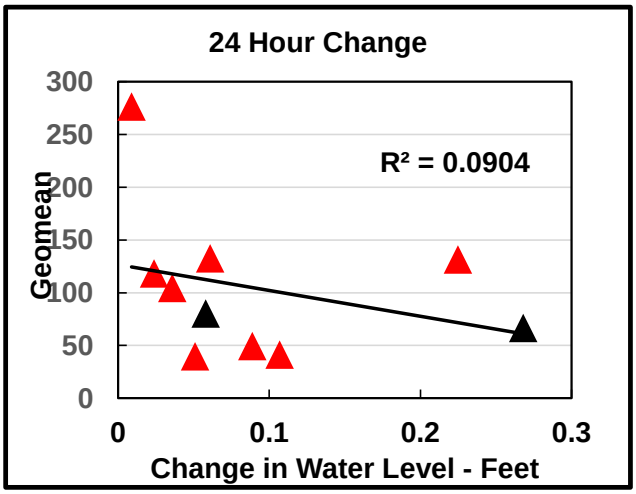
Geomean = 49.3

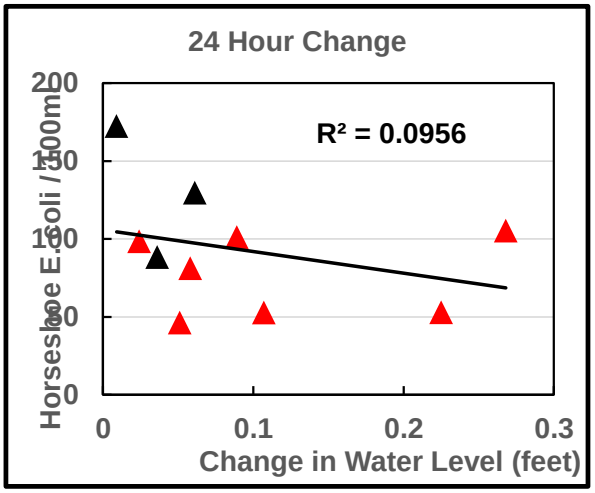
Huntington River Study - 2015- Water Level Change

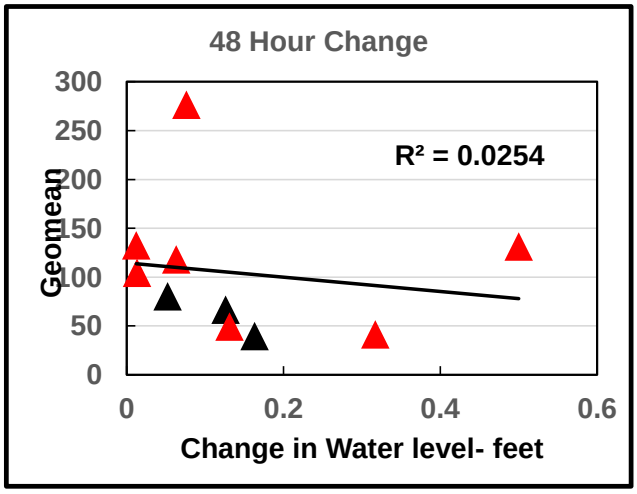
Figure 6.4.1

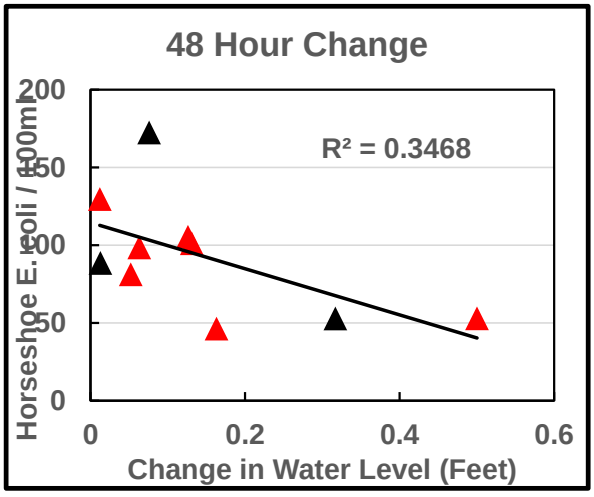






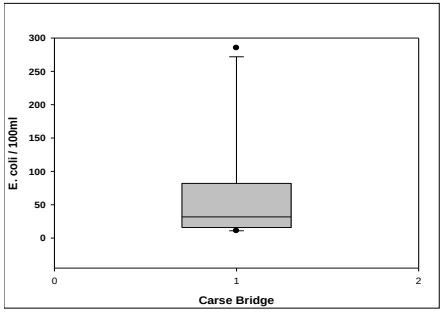


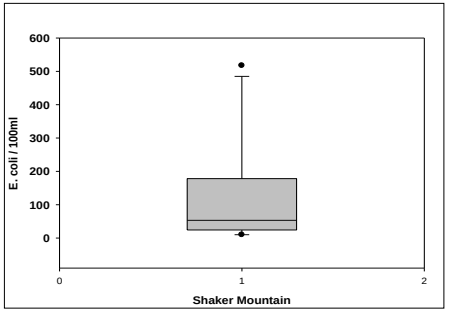


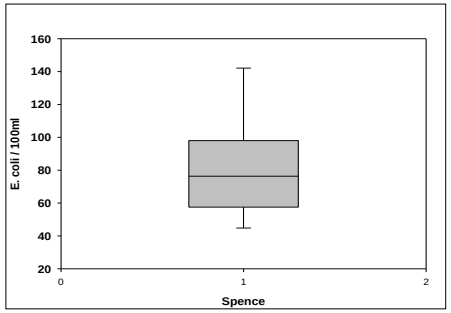


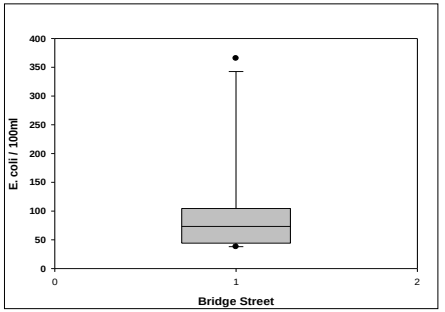
Huntington River Study - 2015

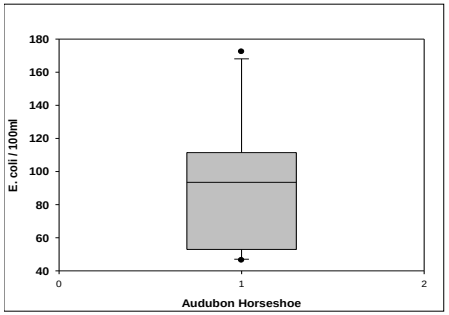
Figure 7

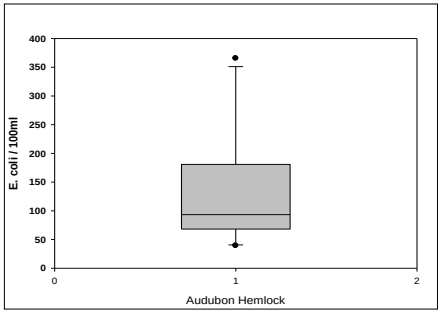


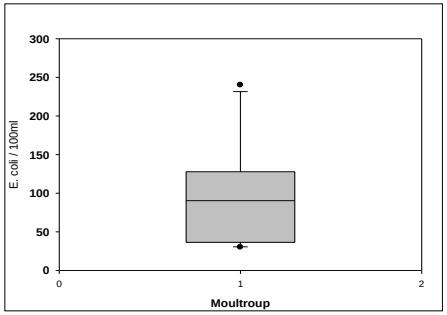


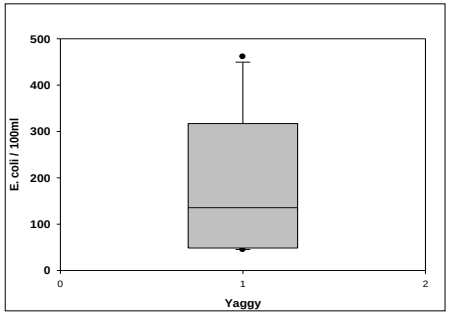


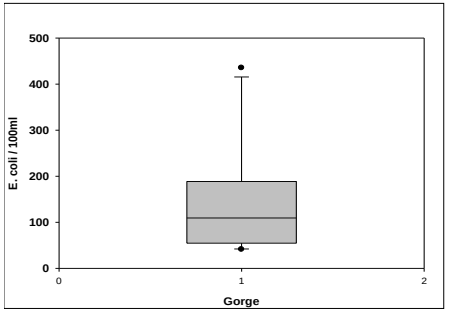


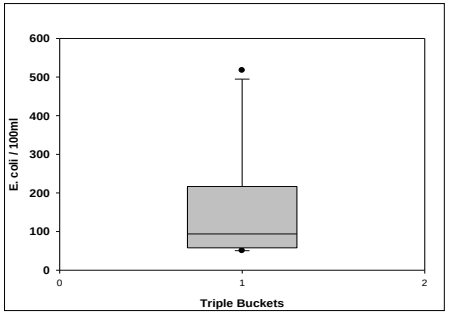






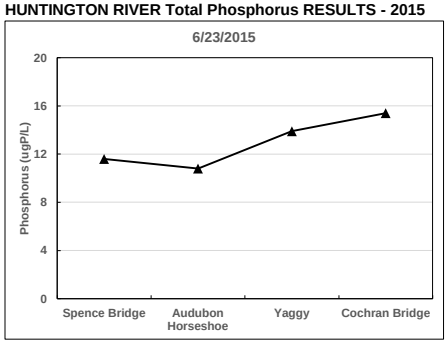


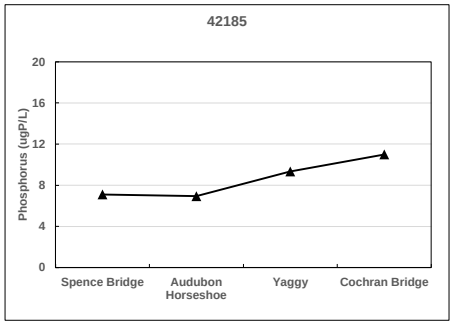


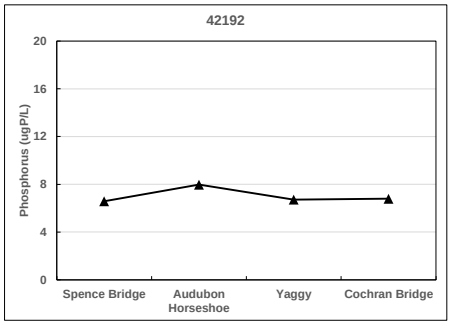


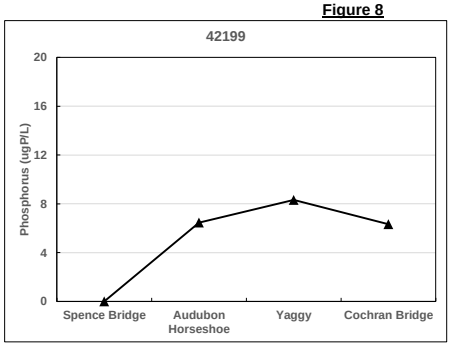
HUNTINGTON RIVER Total Phosphorus RESULTS - 2015

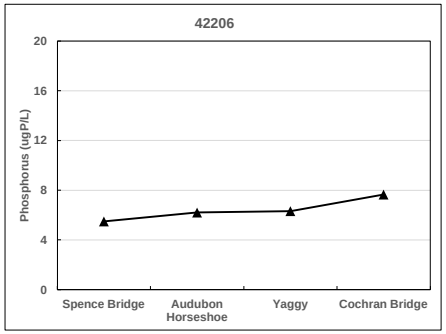
Figure 8

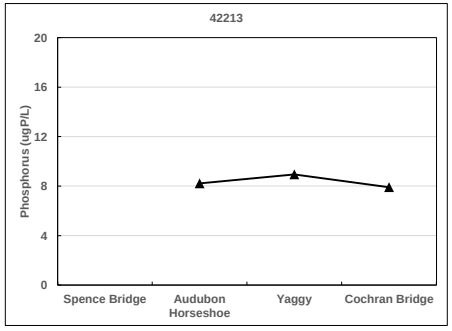


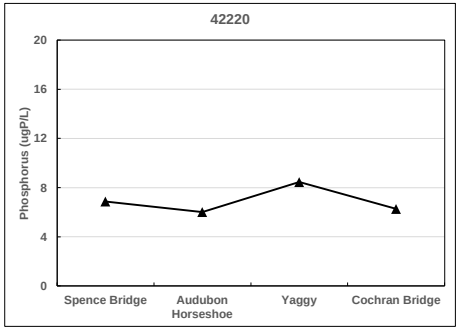


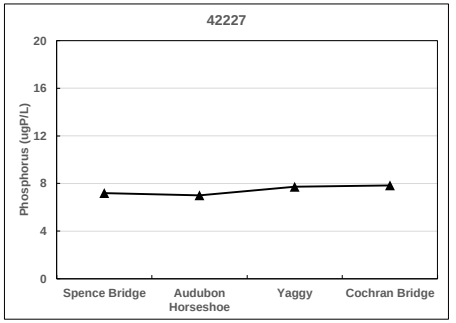


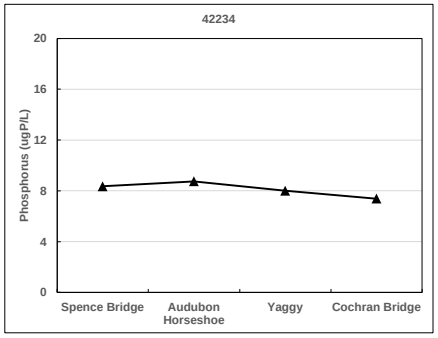


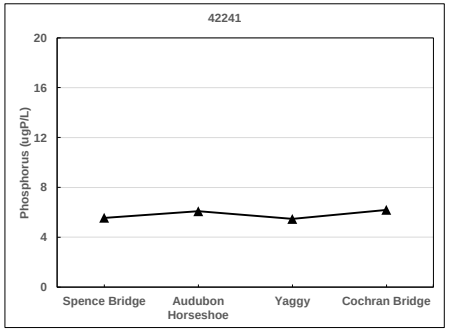


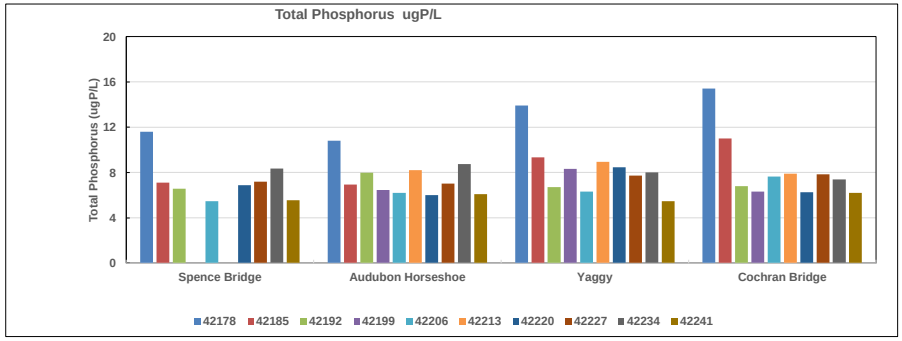












HUNTINGTON RIVER E. COLI STUDY RESULTS - 2015

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Table 1

	6/23/2015	6/30/2015	7/7/2015	7/14/2015	7/21/2015	7/28/2015	8/4/2015	8/11/2015	8/18/2015	8/25/2015	GEOMEAN	Mean	Median
Carse Bridge	285.10	10.89	11.00	30.89	58.33	152.86	24.05	32.67	38.77	17.31	**37.11**	66.2	31.78
Shaker Mtn	517.21	9.79	13.23	47.98	27.85	195.59	90.86	58.33	172.33	40.77	**60.45**	117.4	53.16
Spence Bridge	142.09	71.73	48.66	44.79	66.31		107.58	88.41	86.24	76.34	**76.73**	81.4	76.34
Bridge Street	137.61	39.86	45.68	93.31	67.66	365.40	78.94	93.31	66.31	37.86	**79.96**	102.6	73.30
Audubon Horseshoe	52.98	52.84	46.38	88.41	105.37	172.33	129.63	81.26	98.54	101.22	**85.91**	92.9	93.48
Audubon Hemlock	73.28	166.95	39.31	159.67	93.31	365.40	93.31	52.91	222.36	79.76	**108.65**	134.6	93.31
Moultrop Bridge	155.25	30.13	36.92	68.88	48.82	240.03	117.76	111.90	118.74	34.98	**77.31**	96.3	90.39
Yaggy	172.33	48.74	141.37	344.80	79.76	461.11	307.59	47.98	129.63	45.00	**129.20**	177.8	135.50
Gorge	135.40	55.55	107.58	172.16	56.33	435.17	238.22	52.08	111.23	41.03	**106.82**	140.5	109.41
Triple Buckets	114.46	68.88	50.36	135.44	60.15	517.21	290.93	73.28	191.79	51.22	**113.36**	155.4	93.87
Chalet Trail	71.73	54.75	28.82	172.16	48.74	235.93	198.90	275.51	107.58	34.98	**92.57**	122.9	89.66
Cochran Bridge	78.94	30.05	31.29	201.42	166.40	178.53	261.25	187.19	248.90	109.01	**119.41**	149.3	172.47
GEOMEAN	**131.3**	**41.3**	**39.6**	**104.4**	**66.6**	**276.5**	**132.5**	**80.3**	**118.1**	**49.3**	**87.28**		
Water level													
Values are mpn / 100 ml	Above Federal level (235)									Huntington	**71**		
	Above State Level (77)									Richmond	**112**		

Values are mpn / 100 ml

Values above Federal Standard: 235

Monthly Samples		**30-Jun**				**28-Jul**				**25-Aug**
Texas Hill Brook		13.50				50.41				19.67
Fargo Brook		23.07				435.17				41.35
Hollow Brook		122.29				770.10				1119.87
Brushy Brook		7.45				79.76				55.55
Carpenter Brook										
Cobb Brook		7.31								
7 Falls		21.09				116.19				

Floating										
Hollow Brook Culvert #2										195.59

Duplicates	**6/23/2015**	**6/30/2015**	**7/7/2015**	**7/14/2015**	**7/21/2015**	**7/28/2015**	**8/4/2015**	**8/11/2015**	**8/18/2015**	**8/25/2015**
Carse Bridge	488.44									
Shaker Mtn		17.12								
Spence Bridge										
Bridge Street				74.3						78.5
Audubon Horseshoe										
Audubon Hemlock						344.8				
Moultrop Bridge								143.87	114.46	
Yaggy										36.92
Gorge										
Triple Buckets										
Chalet Trail	78.94									
Cochran Bridge		45.49								
Texas Hill Brook		13.5								
Fargo Brook										
Hollow Brook										
Brushy Brook										
Carpenter Brook										
Cobb Brook										
7 Falls										

Overall Results Composite - 2005-2014

Table 2

2005

	6/22/2005	6/29/2005	7/6/2005	7/13/2005	7/20/2005	7/27/2005	8/3/2005	8/10/2005	8/17/2005	8/24/2005	8/31/2005	9/7/2005	9/14/2005	9/21/2005	9/28/2005	2005 GeoMean
T Falls	131	30	117	98	26	95	39	55	9	37	1120	9	9	12	12	42.1
Carse Bridge	228	38	276	43	96	162	42	866	41	84	2419.6	37	8	18	18	**81.5**
Sheldrake	261	48	291	45	137	172		19	24	44	980		517	16	33	**88.6**
Brent Field	272	70	276	210	115	231	50	88	31	40	1200	34	33	9	921	**103.9**
Shaker Mount	461	66	276	69	69	167	816	40	90	53	1550	88	53	20	44	**113.4**
Rec. Field	579	105	649	43	144	261	69	37	21	980	2419.6		46	18	51	**128.7**
Brace Bridge	613	83	308	24	101	291	66	35	19	572	2419.6		93	28	34	**113.9**
Spence Bridg	816	99		61	71	411	95	35	18	58	1990	397	141	23	54	**114.8**
East Street	488	85	1120	45	68	276	63	32	43	71	2419.6	228	66	34	24	**114.0**
Bridge Street	770	60	980	38	80	548	79	46	55	205	687	222	83	33	31	**128.3**
Cemetery	387	101	921	47	166	613	95	52		153	2419.6	166		38	40	**167.1**
Audubon Hon	147	132	1200	62	137	365	71		37	95	579	192	88	30	37	**123.7**
Audubon Hon	131	68	1730	63	83	401	77	112	37	112	435	192	125	24	29	**115.2**

2006

	20-Jun-06	27-Jun-06	5-Jul-06	11-Jul-06	18-Jul-06	25-Jul-06	1-Aug-06	8-Aug-06	14-Aug-06	22-Aug-06	29-Aug-06	5-Sep-06	12-Sep-06	19-Sep-06	GEOMEAN
Sheldrake	114	116	56	**178**	48	50	**130**	32	10	39	22	14	24	19	42.9
Shaker Mount	**152**	**179**	56	79	60	58	**64**	19	18	71	22			12	48.6
Brace Bridge	86	**249**	43	79	40	102	**156**	**687**	66	**156**	36	60	21	20	77.8
Spence Bridg	125	**186**	28	88	**125**	66	**248**	61		**137**		36	32	6	66.0
East Street		**172**	38	61	**179**	12	110	55	22	79	31	37	22	43	55.3
Bridge Street	**130**	**228**	57	69	**201**	57	**131**	61	18	78	26	26	14	28	57.2
Cemetary	**144**	**214**	55	52	172	59	114	83	22	72	28	20	15	22	55.3
Audubon Hon	**179**	**387**	49	36	118	82	**214**	45		81	58	22	18	18	65.2
Audubon Hon	112	**387**	50	56	**145**	111	**140**	59	23	96	20	37	17	13	58.7
Moultrop Brid	**186**	**308**	48	28	91	55	**172**	51	22	**167**	25	20	13	12	51.7
Dugway West	**161**	**461**	56	**161**	93	63	**1410**	52	36	107	22	**1730**	6	44	**101.9**
Yaggy	**173**	**461**	60	**140**	105	86	**172**	49	21	102	51	**133**	12	49	78.9
Gorge	**199**	**326**	**138**	69	74	**150**	51	18	18	88	31	77	15	34	70.9
Triple Bucket	**291**	**387**	86	**210**	56	72	**145**	41	11	121	16	61	13	28	64.8
Chalet Trail	**365**	**313**	91	108	69	62	96	42	17	102	19	38	11	22	58.8
Cochran Brid	**411**	**461**	72	**130**	55		**219**	36	20	96	20	66	24	43	74.0
Winooski Jonesville					105	**172**	124	63	30	**1550**	101	63	**142**	14	98.2
Winooski Bridge St					67	121	114	68	18	**980**	98	72	105	12	**79.3**
GEOMEAN	173	260	56	87	91	76	159	56	21	126	31	51	20	21	

2007

	6/18/2007	6/25/2007	7/2/2007	7/9/2007	7/16/2007	7/23/2007	7/30/2007	8/6/2007	8/13/2007	8/20/2007	8/27/2007	9/4/2007	9/10/2007	9/17/2007	GEOMEAN
Carse Bridge	74	62	56	**548**	**81**	66	46	69	**1050**	68	23	36	260	39	**87.0**
Shaker Mtn	**96**	50	**135**	**166**	**96**	52	68	51	**727**	**260**	**79**	7	214	30	**86.2**
Brace Bridge	71	68	56	**156**	62	**79**	68	68	**1990**	27	23		162	30	**80.3**
Spence Bridg	**75**	40	26	236	**96**	**93**	**108**	34	**1990**	18	29		249	33	**79.6**
East Street	**131**	41	38	**219**	**326**	**78**	57	20	**416**	18	**411**	33		30	**78.0**
Bridge Street	**127**	26	67	**210**	**248**	64	71	25	**387**	7	**1300**		517	41	**99.8**
Cemetery	**70**	40	52	**201**	54	46	62	22	**150**	13	35	26	629	43	**57.9**
Audubon Hon	**111**	46	**201**	**193**	**84**	55	44	22	**91**	7	13		687	37	**61.8**
Audubon Hon	**58**	**28**		**435**	**82**	**81**	24	11	**36**	14	7	21	435	26	**41.3**
Moultrop Brid	**78**	**67**	**46**	**228**	**114**	**58**	**39**	**23**	**613**	**15**	**14**	**17**	387	**18**	**58.1**
Above Owl's Head				214	**105**	**308**	**59**	**29**	**2420**	**126**			548	**57**	**169.1**
Dugway West	**192**	**193**	**99**	**285**	**118**	**1730**	**56**	**34**	**1120**	**131**	**43**	**56**	649	55	**156.2**
Yaggy	**130**	**185**	**96**	**365**	**96**	**54**	**69**	**31**	**143**	**76**	**53**	**28**	770	**52**	**96.5**
Gorge	**133**	**291**	**83**	**435**	**71**	**68**	**50**	**23**	**365**	**96**	**36**	**29**	727	**52**	**100.5**
Triple Buckets	**99**			**488**	**70**	**60**	**32**	**27**	**178**	**66**		**11**	281	**33**	**70.4**
Chalet Trail	**74**	**192**	**61**	**261**	**74**	**78**	**26**	**18**	**345**	**66**	**18**	**5**	197	**50**	**62.0**
Cochran Brid	**63**	**201**	**149**	**201**	**82**	**69**	**29**		**461**	**214**	**11**		299	**84**	**104.4**
Winooski Jon	**36**	**44**	**27**	**236**	**158**	**101**	**172**	**5**	**22**	**18**	**56**	**9**	579	**285**	**57.7**
Winooski Brid	**81**	**41**	**43**	**219**	**210**	**81**	**326**	**38**	**34**	**20**	**35**	**42**	548	**249**	**84.2**
GEOMEAN	**93.5**	**74.6**	**69.1**	**264.9**	**96.7**	**87.0**	**49.5**	**28.3**	**430.5**	**40.7**	**37.9**	**13.9**	**389.3**	**39.3**	**82.4**

2008

	2/10/1900	6/30/2008	7/7/2008	7/14/2008	7/21/2008	7/28/2008	8/4/2008	8/11/2008	8/18/2008	8/25/2008	9/2/2008	9/8/2008	9/15/2008	9/22/2008	GEOMEAN
Carse Bridge	46	93	128	488	186	41	77	45	56	73	117	35	53	23	74
Shaker Mtn	40	116		488				55	86	91	18	31	105	20	64
Brace Bridge	16	142	91	488	138	167	86	236	45	116	49	55	50	15	81
Spence Bridg	19	152	122	770	147	167	111	61	40	84	26	27	56	35	76
East Street	416	291	96	1300	153	365	111	38	41	91	33	38	579	49	132
Bridge Street	649	166	72	1550	261	345	117	45	46	86	135	25	816	34	147
Cemetery	727		96	422	308	225	121	48	46	88	40	28	66	41	103
Audubon Hon	435	112	125	1550	345	205	88	54	56	125	31	21	56	46	110
Audubon Hon	770	152	93	1730	365	193	93	56	30	50	36	32	45	40	106
Moultrop Brid	1300	123	199	2420	328	276	91	55	30	58	20	22	34	16	103
Dupway West	770	144	179	2420	219	167	82	76	488	30	39	30		19	132
Yaggy	727	186	155	1990	687	205	96	74	99	41	29	40	62	11	120
Gorge	770	308	93	2420	411		63	68	41	48	17	24		12	99
Triple Buckets	727	152		2420	411	199	119	77	33	33	16	28	40	4	87
Chalet Trail	387	148	99	2420	272	228	166	52	25	35	9	18	50	3	74
Cochran Brid	365	162	52	2420	488	411	93	66	31	31		31	55	60	118
Winooski Jon	299	132	18		2420	299	210	1550	63	45	19	21	59		122
Winooski Ric	205	199	54	613	1990	291	345		96	51	15	30	133	66	136
GEOMEAN	**282**	**156**	**92**	**1259**	**362**	**214**	**111**	**75**	**53**	**59**	**29**	**29**	**79**	**22**	**102**

2009

	6/30/2009	7/7/2009	7/14/2009	7/21/2009	7/28/2009	8/4/2009	8/11/2009	8/18/20089	8/25/2009	9/1/2009	9/8/2009	9/15/2009	9/22/2009	9/29/2009	GEOMEAN
Carse Bridge		88.2	78.41		198.9	23.07	218.72	224.68	35		10	68	11	10.89	**50**
Shaker Mtn	95.99	95.9	66.31	66.95	44.1	34.05	770.1	27.51	35.9	9	12		23.07	55.9	**48**
Brace Bridge	108.6	178.9	98.81	59.8	44.8	67.66	547.5	78.94	54.6	39	16	727	11		**78**
Spence Bridg	108.07	86.5	50.41	38.39	66.2	42.57	1203.33	54.48	21.6	75	12	276	10.89		**62**
East Street	193.49	83	107.58	41.35	71.7	60.86	461.11	53.81	47.9	37		107	11.99	41.95	**69**
Bridge Street	151.52	111.9	127.4	77.12	81.6	72.27	2419.6	49.54	53.7	67	17	56	30.89	34.05	**80**
Cemetery	201.42	117.8	81.62	73.28	46.5	65.04	410.58	53.81	52.9	25	30	172	13.5	37.86	**66**
Audubon Hon	186	111.9	24.62	49.64	51.2	60.53	172.33	51.21	39.9	52	22	84	64.47	76.34	**62**
Audubon Hon	142.09	104.3	52.91	50.41	83.9	54.61	75.89	74.91	69.7	27	19	115	8.6	56.53	**55**
Moultrop Brid	172.47	110.6	41.65	43.47		73.28	65.04	58.63	52	36	9		8.6	48.74	**45**
Dupway West	198.9	118.7	59.01		56.5	61.27	68.28	54.61	31.4	31	29	214	9.79	55.55	**56**
Yaggy	307.59	142.1	37.86	74.91	67.7	68.88	34.51	49.59	79.4	36	20	112	13.36	71.73	**59**
Gorge		117.8	44.12	60.86	62.7	57.31	51.21	47.11	35	22	16		4.09	71.16	**38**
Triple Buckets		145.5	52.04	34.51	67.7	60.15	29.54	38.93	22.6	12	16	158		32.67	**42**
Chalet Trail	298.66	77.1	50.39	58.06	56.1	65.04	37.86	24.33	23.1		9	222	3.04	59.8	**43**
Cochran Brid	261.25	166.9	57.31	56.33	48.8	90.49	20.11	35.92	36.4	38	16	121	22.55	114.46	**56**
Winooski Jon	960.61	113.7	120.07	37.96	54.6	236.93	40.2	36.41	44.3	76	46	71	5.21	336.15	**75**
Winooski Ric		81.6	98.54	48.74	45.7	146.72	46.54	25.59	52.1	76	8		10.05	207.54	**52**
GEOMEAN	**198**	**111**	**63**	**53**	**63**	**65**	**135**	**50**	**41**	**35**	**16**	**139**	**12**	**60**	**56**

2010

	6/29/2010	7/6/2010	7/13/2010	7/20/2010	7/27/2010	8/3/2010	8/10/2010	8/17/2010	8/24/2010	8/31/2010	9/7/2010	9/14/2010	9/21/2010	GEOMEAN
Carse Bridge	159	70.83	39.86	78.94	74.9	129.63	86.47	11.76	23.07	6.26	11	20.11	2.01	**31**
Shaker Mtn	43	25.3	63.41	40.44	86.47	201.42	63.14	166.4	49.59	24.62	83.29	20.34	29.76	**54**
Brace Bridge	39	62.44	47.87		64.37	218.72	104.6	148.32	410.58	21.57	78.94	37.86	14.49	**68**
Spence Bridg	69	67.66	76.34	66.33	47.25	275.51	120.7	83.29	178.21	10.89	178.9	28.47	20.64	**68**
East Street	62	32.67	61.98	59.8	54.61	410.58	218.72	69.68	34.05	41.65	65.68	34.98	18.9	**61**
Bridge Street	102	48.74	83.61	113	146.95	517.21	214.26	70.27	57.31	66.31	44.34	39.31	19.89	**82**
Cemetery	59	80.88	90.75	129.06	67.66	461.11	344.8	75.41		48.74	25.9	31.84	18.69	**75**
Audubon Hon	61	50.41	119.83	83.92	83.92	648.82	435.17	53.71	39.31	24.33	35.45	39.31	27.51	**72**
Audubon Hon	67	49.54	108.6	110.61	54.61	579.43	325.54	44.12	48.82	34.05	27.85	31.45	35.45	**70**
Moultrop Bridge			108.7	107.58	46.38	1119.87	488.44	43.71	29.76		16.13	33.61	24.91	**74**
Dugway West	107	77.12	151.52	101.68	75.89	1299.65	648.82	29.17	54.61	14.64		29.17	17.31	**82**
Yaggy	186	59.4	124.57	86.24	68.28	1046.24	686.87	27.85	47.11	20.11	12.23	22.3	16.94	**68**
Gorge	105	51.22	178.9	90.63	63.14	2419.6	488.44		47.88	21.33	14.64	13.36	13.36	**71**
Triple Buckets	99		115.28	83.92	34.05	1119.87	189.42	25.3	36.41	36.84	6.2	15.96	15.79	**52**
Chalet Trail	135	30.51	104.26		31.45	980.39	161.62	20.34	44.79	14.64	7.38			**54**
Cochran Brid	93	53.81	114.46	79.36	38.39	1203.33	686.87	24.33	54.48	30.51	40.2	13.23	7.45	**63**
Winooski Jon	1986	19.89	32.25	49.59	65.68	27.85	1046.24	32.25	81.26	19.89	26.21	19.89	21.82	**57**
Winooski Ric	2420	31.84	38.39	45	40.2	75.89		47.98	137.35	26.21	41.35	30.51	22.81	**60**
GEOMEAN	**123.3**	**47.1**	**83.1**	**78.7**	**59.6**	**451**	**270**	**45**	**59**	**24**	**29**	**26**	**17**	**63**

2012

	6/25/2012	7/2/2012	7/9/2012	7/16/2012	7/23/2012	7/30/2012	8/6/2012	8/13/2012	8/20/2012	8/27/2012	9/4/2012	9/10/2012	9/17/2012	GEOMEAN
Carse Bridge	209.82	33.1	17.12	307.59	162.42	29.4	290.93	20.11	9.51	113	24.62	19.89	2.02	**42**
Shaker Mtn	166.4		24.62	98.76	19.89	26.55	410.58	35.46	13.5	20.11	25.3		24.91	**41**
Brace Bridge	410.58	25.9	36.84	178.9	66.31	133.44	726.99	45.68	8.6	185.01	60.15	39.31	18.90	**72**
Spence Bridg	517.21	63.14	37.86	151.52	50.39	48.74	579.43	60.53	18.69	139.58	9.69	35.92	22.81	**64**
East Street		52.08	57.31	160.71	65.04	35.92	579.43	55.39	14.35	101.44		48.08	28.20	**64**
Bridge Street	435.17	52.04	39.86	165.76	34.51	27.85	726.99	54.61	12.11	143.87	23.78	68.28	15.96	**63**
Cemetery		75.41	48.82	123.56	33.1		920.84	51.22	17.31	143.87		86	24.62	**72**
Audubon Hon	866.44	47.25	52.84	80.88	30.13	35.92	517.21	52.91	34.05	123.56	60.15	50.41	16.94	**71**
Audubon Hon	488.44	56.33	60.15	67.66		38.77	648.82	50.39	30.13		19.46	39.31	16.77	**62**
Moultrop Brid	344.8	52.01	60.86	186.95	193.49	34.05	980.39	50.41	49.59	18.69	34.98	42.23	14.49	**71**
Dupway West	261.25	63.67	61.98	83.61	387.32	45.19	2419.57	49.54	42.57	42.84	90.63	41.35	12.23	**86**
Yaggy	224.68	88.59	82.9	78.94	201.42	61.27	770.1	61.55	34.05	24.05	61.27	30.51	18.90	**75**
Gorge		78.94	88.59		218.72	37.44	579.43	68.28	20.34	21.57	49.82	43.47	14.89	**59**
Triple Buckets		51.21		93.22	24.33	41.08	209.82	61.98	13.36	25.59	32.67	29.92	0.00	**43**
Chalet Trail	178.53		68.88	61.98	37.86	37.86	613.14	65.65	27.18	23.78	17.49	25.90	5.21	**45**
Cochran Brid	461.11	50.39	100.82	101.22		178.9	517.21	98.31	25.91	44.34	2419.57	20.11	53.62	**133**
Winooski Jon	29.54	360.87	39.31	6.32	13.23	49.54	209.82		5.16	14.49	6.26	30.89	70.83	**29**
Winooski Richmond		38.77	24.91	37.34	23.78	95.94	151.52	248.9	33.91	19.89	27.18	44.34	55.73	**48**
GEOMEAN	**318.6**	**53.9**	**50.9**	**116.2**	**116.2**	**45.3**	**619**	**53**	**22**	**56**	**45**	**38**	**6**	
Conductivity	136	110	122.5	141.9	143	112.5	112.5	114.6	126.4	157.5	161.9	127.1	149.6	
Water temp (C	18.4	17.2	15.1	20.4	21	18.8	18.8	17.9	16.3	19.3	18.4	14.4	11.9	
Water level	0.59	0.71	0.63	0.39	0.39	1.00	1.00	0.82	0.56	0.45	0.41	0.67	0.48	

2013

	6/25/2013	7/2/2013	7/9/2013	7/16/2013	7/23/2013	7/30/2013	8/6/2013	8/13/2013	8/20/2013	8/27/2013	9/3/2013	9/10/2013	GEOMEAN
Carse Bridge	770.10	435.17	28.13	235.93	325.54	59.4	17.49	20.86	17.12	186	77.12	14.80	**79**
Shaker Mtn	461.11	161.62	29.92	54.61	488.44	63.14		27.51	53.71	435.17	146.72	36.92	**102**
Brace Bridge	410.58	235.93	73.89	33.1	178.21	48.74	26.86	44.12	47.11	123.35	101.44		**84**
Spence Bridg	816.41	260.25	36.84	26.86	150.01	69.07	18.69	43.47	58.33	365.40	201.42	18.69	**85**
East Street	816.41	517.21	37.44	52.91	155.25	73.28		37.34	47.98	461.11	142.09	22.55	**109**
Bridge Street	791.53	272.30	59.4	52.04	146.72	116.19	25.59	51.21	52.08	816.41	129.63	34.98	**109**
Cemetery	1553.12	290.93	62.66		190.38	114.46	27.18		52.04	1119.87	151.52		**174**
Audubon Hon	1299.65	461.11	75.41	58.78	461.11	95.9	34.98	72.27	25.59	344.80	290.93	32.67	**131**
Audubon Hon	1986.29	365.40	64.47	61.27	116.02	151.52	34.98	28.47	17.31	307.59			**110**
Moultrop Brid	1553.12	344.80	74.39	54.61	63.67	155	18.9		35.92	410.58	55.96	15.79	**94**
Dugway West		365.40	86	61.98	67.01	155.25		51.22	17.49	344.80	285.10	23.07	**92**
Yaggy	980.39	410.58	57.31	48.74	72.15	135.4	43.71	34.54	27.85	435.17	248.9	31.84	**104**
Gorge		365.40	48.08									24.33	**75**
Triple Buckets	239.23	488.44	56.53						12.11	122.29		17.49	**75**
Chalet Trail	1203.33		52.04	52.91	46.38		40.20			115.28	387.32		**116**
Cochran Brid	1413.61	378.40	74.39	45.68	83.29	135.4	34.51			325.54	461.11	54.48	**150**
Winooski Jon	980.39	228.18	866.44	32.67		344.11	35.45				70.27		**177**
Winooski Richmond				31.29	68.88	307.59	50.39	161.62		60.86			**83**
GEOMEAN	**888.5**	**342.4**	**54.6**	**55.3**	**55.3**	**98.2**	**28.1**	**38.8**	**31.6**	**324.3**	**173.9**	**25**	

2014

	7/1/2014	7/8/2014	7/15/2014	7/22/2014	7/29/2014	8/5/2014	8/12/2014	8/19/2014	8/26/2014	9/2/2014	GEOMEAN	Median
Carse Bridge	30.89	43.77	59.4	123.56	90.49	24.05	6.32	9.69	1.00	8.60	**20**	27.5
Shaker Mtn	44.79	56.79	71.73	224.68		57.31	33.1	13.23	39.31	29.54	**47**	44.8
Brace Bridge	42.57	69.45	133.44	201.42	135.37	52.04		7.45	23.07	36.92	**53**	52.0
Spence Bridg	137.61	57.31	123.56	60.53		46.54	21.33	14.80	27.18	42.97	**46**	46.5
East Street	57.31	128.66	101.93	47.25	142.09	51.21	36.36	15.79	47.98	38.39	**55**	49.6
Bridge Street	41.35	78	136.44	54.75	224.68	39.31		21.33	21.33	65.04	**57**	54.8
Audubon Hon	137.35		124.98	47.37	228.18			22.05	21.33	36.36	**61**	47.4
Audubon Hon	98.67		90.63	63.14	276			25.30	18.49	29.76	**58**	63.1
Moultrop Brid	124.57	137.35	137.61	45.00	365	46.54	21.33	30.51	17.31	45.00	**63**	45.8
Yaggy	73.28	84.2	125.91	69.68	285	96.03	36.41	20.11	18.29	28.82	**60**	71.5
Gorge	72.27	109.51	126.69	95.94	411	83.92	22.55	32.67	19.89	28.47	**65**	78.1
Triple Buckets	75.41	79.76	88.41	71.36	365	41.95	32.67	15.63		19.89	**57**	71.4
Chalet Trail	73.80		101.44	39.86	461	63.67	25.59	17.49	21.82		**55**	51.8
Cochran Brid	59.40	166.4	261.25	166.4	435	57.08	46.54	14.64	13.36	31.84	**71**	58.2
Winooski Jon	49.64	48.08		71.73	1986	30.89	32.25	35.92	39.86	86.47	**70**	48.1
Winooski Ric	49.54	93.38		29.17	2420	53.81	66.95	65.04	90.86	139.58	**100**	67.0
GEOMEAN	**69.1**	**85.0**	**113.2**	**79.1**	**256**	**51.9**	**25.4**	**17.3**	**17.8**	**31.1**		60.5

Huntington River Study: Year-by-Year Comparisons* **Table 3**

	2004**	2005**	2006	2007	2008	2009	2010	2012	2013	2014	2015****
Overall Geomean	58	110	64	88	103	57	65	61	105	53	87
Overall Geomean: Huntington	58	110	59	75	99	63	65	60	106	48	71
Overall Geomean: Richmond	Not done	Not done	72	102	85	49	66	56	98	61	112
Days when overall Geomean for the day > Federal	2	3	1	3	3	0	2	2	3	1	0
Days when overall Geomean for the day > State	4	10	6	6	9	4	5	3***	4***	2	9
Total samples > Federal	20	48	19	39	61	12	25	27	48	11	16
Total samples > State* **	40	98	58	94	137	58	79	37	75	35	47
Overall Geomean for any site over season > Federal	0	3	0	0	0	0	0	0	0	0	0
Overall Geomean for a site over season > State* **	0	12	5	12	14	4	2	2	14	1	6

*Winooski River samples not included

**Huntington Segment only was studied

*** State Standard became Federal Standard in 2012. Indicated number based on old State Standard = 77, for purposes of comparison with previous years.

****Two fewer sites

2015 Huntington River E. coli Field Duplicates **Table 4**

Date	Location	Results		Relative Percent	Absolute Difference
		A	B		
6/23/2015	Carse	285.1	488.44	71.3	203.3
6/23/2015	Chalet	71.73	78.94	10.1	7.2
6/30/2015	Shaker	9.79	17.12	74.9	7.3
6/30/2015	Cochran Bridge	30.05	45.49	51.4	15.4
6/30/2015	Texas Hill	13.50	13.50	0.0	0.0
7/14/2015	Bridge Street	93.31	74.30	20.4	19.0
7/28/2015	Audubon Hemlock	365.40	344.80	5.6	20.6
8/11/2015	Moultroup Bridge	111.90	143.87	28.6	32.0
8/18/2015	Moultroup Bridge	118.74	114.46	3.6	4.3
8/25/2015	Bridge Street	37.86	78.50	107.3	40.6
8/25/2015	Yaggy	45.00	36.92	18.0	8.1
			Mean	**35.6**	